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ABSTRACT

Educational technology tends to be characterized by a lack of targets; therefore, it is time for education to define its targets in aspiring to the school of the future and consider the option of calling in experts from other fields to help in problem solving. This paper predicts that while classroom design may not change too much, classrooms will group children more by cognitive ability than by chronological age. The library will be virtually paperless and equipped with CD-ROMs and fast links to many kinds of databases. Curriculum and syllabus design will emphasize multicultural awareness, universal moral values, insight into one's own thinking processes, and a spirit of broad inquiry. Lesson plans will maximize the technological capabilities of the classroom. Student grading will include self-assessment and recognition of progress. To achieve this vision, computer scientists may have to be consulted for information on ergonomics and man-machine interaction. Psychologists might need to be available to help those having trouble adjusting to shifts in cognitive demands. Other teachers, moreover, might have to be enlisted to teach very specialized skills. (Contains 17 references.) (BEW)

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BEFORE THE CHALLENGE

by
Demetres Pnevmatikos

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Quality in education is a central preoccupation in all developed countries. Improving the quality of basic education--primary and secondary--obviously comprises a number of changes in curricula, teaching methods, and the organization of schooling with particular emphasis on the role of the teaching staff. On the other hand, teachers have begun to be dissatisfied with the inability of the school to link school and society. Many teachers, also, have turned towards technology because of "a felt need to reflect the nature of our rapidly changing society in education and to underline its relevance for all pupils" (Dodd, 1978, p. 37). From this point of view, education has always followed technological advances in trying to apply scientific achievements to teaching practice. Contrary to the other fields, educational technology is characterized by a lack of targets. Although, multimedia applications, for example, promised rapid changes in education, there is no plan to assimilate these ideas and knowledge. Therefore, it is time for education to define its targets in aspiring to the school of the future and call in experts that could solve the problems that might arise. This implies that the psychologists, pedagogists, and computer scientists should cooperate to solve the problems which arise. In order to show what I mean exactly, in this paper I shall attempt to describe the school of the future and I shall point out some of the problems that must be resolved from each science.

The School of the Future

Forgive me, if the first part of my proposal seems like a science fiction story but as Denis Healy (1987) said: "The application of information technology to education requires new and imaginative approaches" (Lesgold, 1987, p. 13).

Classroom Organization

The structure of a classroom in a school of the future will not be too different from a current classroom. The classroom will still have its blackboard. On one side, behind the teacher's desk, there would be a screen whose size would vary with the size of the classroom. On the teacher's desk, there would be a high capacity multimedia system, equipped probably with peripheral CD-ROM, full-motion video, touch sensitive screen, voice/document delivery system, printer, etc. On the desks there would be PCs equipped with appropriate software for every lesson. They would have a CD-ROM as well as CD-WRITE and an on-line link with the school's library.

Class-Student Organization

A common feature of all students of each class will not be their chronological age but the possession of the same level of cognitive abilities, corresponding to the requisite level for the comprehension of every unit of the lesson. Students would be tested on every subject and assigned to a class in accordance with the results.

Library Organization

The school's library will not have books, magazines, or newspapers. It will have a computer capable of linking with databases and in a short time it will be able to provide information for everything that has been written, providing writing ability of information on a CD-ROM, for further processing, for every type of school There will also be in the library a relevant software series with multimedia encyclopedias so that students are informed directly. The contents of encyclopedias would be graduated according to the level of cognitive demand.

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Curriculum and Syllabus Design

If we accept that the spectrum of scientific knowledge of every scientific region is reproduced almost every ten years, it is apparent that the curriculum should be reorganized and the educational values required in future life should be evaluated. Therefore, the curriculum's objective targets will provide to its students a fundamental body of knowledge for every scientific field. They should stress the cultural educational values of each country and encourage a sense of universal moral values in combination with the commonly accepted educational values which would be necessary for the conservation of our planet. The curriculum will put on a scale the knowledge, based on the allocated abilities which are required for their resolution and they will provide to students the ability to attend courses according to the development of their capacities, putting into practice the individualization in teaching. There will be lessons which will help students acquire a clear picture of the way they operate as cognitive beings, laying equal emphasis on metacognition (Flavel, 1979; Wellman, 1985) and on knowledge. The content of the lessons will be clearly defined but beyond the fundamental knowledge, it will provide the opportunity for a broader exploration of the lesson. It will also pose the unanswered questions which engage the field of the lesson for the students to consider these subjects in depth. Teachers, to accomplish every lesson targets, must have the opportunity to select from a series of alternative methods, one of which will correspond to the special need of each student's socioeconomic status.

Teaching Organization
Lesson Planning

Teachers will be aware of students' capacities for the acquisition of new knowledge, and they will also have a clear picture of students individual differences and will be aware of the factors that would potentially affect their teaching. Collaterally, teachers will have in their possession plenty of media and methods to succeed in their target. Teachers shall develop in this way to the maximum degree, the technological potential. Initially, they will be able to present the lesson plan on the screen and pose the questions that will occupy the class during the lesson. By using the multimedia system they will be able to give a vivid picture of the phenomena they will teach not only in laboratory conditions but also in real conditions. Students will be able to experiment on the computer themselves through a simulation program, to search for other useful information from the library, to transmit new knowledge to new applications. To establish the unanswered questions and to formulate possible solutions for these questions or, even better, to experiment about their resolution. Finally, students will be able to evaluate themselves by answering the special test made to test the degree of acquisition of new knowledge. The computer will be able to process (aided by a statistical program like SPSS) the answers automatically and to give the picture of every student's record.

Development Pace
Student Grading

This system will assist the continuous assessment of the students' progress. When students rise to a higher development level in some lesson and possess the fundamental knowledge, then by rights they will be able to attend the lesson at the same level. This means that the importance of the course is not limited to the acquisition of the necessary knowledge but also to the development of cognitive abilities, of self respect, of self awareness, and of meta-cognitive awareness.

The Problems With Computer Science

Multimedia systems provide the potential for multi-sensory presentations and therefore in addition to the fact that they maintain the student's attention during

the lesson, they have the capability to accelerate and improve the comprehension of information. It is a fact that computer science has succeeded to many applications which only a while ago belonged to the field of science fiction. This fact allows us to be optimistic about even more applications in the future. Since 1978, when Philips Laser-Vision was first presented (it was based on a video disk appliance which had the ability to store pictures) we have seen until now more complex applications concerning live video and sound in analogical form. The CD-ROM, the VGA card of IBM, Apple's logismic Hypercard, have progressed to more complex applications like voice/documentary delivery (Scherr, 1989), CD-Write (Udell, 1993). Very simple educational applications have progressed to the Computer-Aided Language Instruction (CAL), (Last, 1984), or the educational encyclopedias like MAMMALS Multimedia Encyclopedia (one complete encyclopedia for the animal kingdom of mammals based on Hypertext), Compton's Multimedia Encyclopedia, the concise Columbia Dictionary of Quotations and Hammond Atlas. In other words, the new information technology offers a wide variety of programs covering nearly all the stages of learning. However, building one's educational program presents some problems. Some of them I shall try to describe now. I will not go into technical details as I am not an expert in this subject. However, I will point out some of the problems that researchers have detected in an attempt to apply useful educational programs for us to have an understanding of them.

Researchers from the Center for educational Research and Innovation (CERI) who consider the building of educational programs for mathematics, emphasize that creating of such programs must include "knowing what the problem is and knowing a method of solving it" (Howe, 1987). Therefore, in building such a program for computers "we can distinguish errors which are due to the inexact or imprecise conceptualization of a problem from errors occurring as a result of representing the problem in program form" (p. 235). That implies that first of all we should have a clear and documented view about the structure of the problem and secondly we should command proportional flexible methods and techniques which will allow us to transmit this structure into the program explicitly. Dr. Jean-Paul Haton (1987) has considered artificial intelligence research for systems that would be able to use all the knowledge, including human expertise, available in a given domain. He considers the application of knowledge-based techniques to understanding systems, especially speech understanding and computer vision where the basic problem consists of interpreting input physical data. In these two related fields, Dr. Haton notices: "there exists a close interaction between numerical data-processing (perceptual aspects such as in signal processing and pattern recognition techniques) and symbolic computation (cognitive aspects). Moreover, it is difficult to implement reasoning processes due to the multiple knowledge sources and to the fact that data are incomplete and/or erroneous (p. 1). We should therefore command a clear view of the symbolic operation of the human's cognitive operations to project them later on in computer operation. We should also know which of the human capacities can be developed by computers and which can not.

Sperandio and Scapin (1987) point out the problems of the ergonomics aspect in man-machine communications:

> Speaking to the machine in natural language may seem more natural than using a keyboard. It is certainly more natural, but not necessarily faster nor safer. First of all, today's machines recognize spoken words only within boundaries that are much more restricted than man to man communication. This technological constraint requires the operator to speak in a more stereotypical way than in everyday life, and to use a

> reduced language. Therefore, the user has a greater risk of violating these boundaries, these rules, than if he/she was using a more classical entry mode, such as a key-board. Current software design can sometimes be described as an art rather than a science, depending more on individual judgment than systematic application of knowledge. It is that knowledge, both in terms of methods and existing results that software ergonomics can provide. (pp. 83-84)

In other words, planners of educational curricula should select from the superabundance of offered techniques the most operative. Even though all programs of new information technology are material well produced, Professor Gilbert de Landshere (1987) pointed out that taken in isolation, and not seen as tools for use in an educational project, many of them are of dubious psychological and pedagogical value. Therefore, criteria of courseware description and evaluation must be adapted, improved, and extended. It is customary to consider the user interface (screen layout, forms of control and feedback, nature of dialogue), the technical quality of the program, and its pedagogical structure and function.

Psychological Problems (Cognitive Sciences)

Cognitive science emphasizes the role of prior knowledge in learning. We have already pointed out the need of the computer programmer to know the exact operation of the human mind to construct a new educational program for a computer. Furthermore, in the first part class organization based on the same level of cognitive abilities in each domain of knowledge was discussed. However, there are many different aspects of the growth and organization of cognitive abilities. Jean Piaget (Inhelder, 1963) suggests a holistic model for the structure and development of the mind. On the contrary, neo-Piagetian researchers propose more flexible systems for the architecture of the mind. Demetriou and Efklides (1993) suggested three different systems (the processing system, the hypercognitive system, and the specialized structural system) in which the human mind is structured. The first one refers to the most general system of intellect. This involves components which are so general that they are present in every intellectual endeavor. The second one, the hypercognitive system, does not have solutions to problems. It simply directs the mind, when it is in a state of uncertainty, to select a course of action that seems more relevant and promising, given the presentation(s) of the solution of the problem. The specialized structural systems are complex modules involving concepts, mental acts, schemes, or operations interconnected into networks that make their co-activation possible for the sake of particular mental goals. These networks may be conceived as abilities. That is to say, they make the person able to understand whole domains of reality and they structure the action required for efficient interactions with the elements of these domains. From this aspect, the mind is conceived more as a network of relations connecting the intellectual units into systems which are functional vis-à-vis the demands of specific environments in the individual's own history (Demetriou, Efklides, & Platsidou, 1993).

Therefore, the structure and organization of knowledge in every special field of reality should have a particular inner structure and organization and should follow a particular developmental rate. This means that the exact structure and developmental rate of every field of reality should be explored and later on educational programs built which would take into account all these specialties. A first step towards this direction, pertaining to religious thinking has already been done (Pnevmatikos, in preparation). It was established that although students possessed the corresponding abilities for a higher level of religious thinking than the one they demonstrated, they remained, however, at a lower level of religious

thinking. The factor which was of significant influence was the socioeconomic status. That means, that research beyond the structure of every form of complex thinking, should be turned into pointing out explicitly all factors responsible for the creation of individual differences. In other words, one must specify precisely the manner in which knowledge is acquired and built in every domain of reality and secondly one should define all factors which are responsible for the creation of individual differences. Today there is no doubt that a thorough analysis of the domain specific knowledge of a person is a necessary requirement for understanding the person's problem-solving activities in each domain (Glaser, 1984). Beside that, there exists a need, as many agree, "metacognitive processes should receive more consideration in development of teaching programs. A teaching program should help explicitly to acquire mechanism to control and monitor the domain-specific knowledge and cognitive skills" (Corre, 1987, p. 167). What is the relevance of metacognition to each one of the fields of reality? Does their influence occur in the same way in all developmental levels? These are questions that should be answered. For the time being, "recent studies of training in the development of cognitive strategies demonstrate the success of cognitive and meta-cognitive training measures with students with learning disabilities, students with different levels of maturity, and students in different college semesters" (Corre, 1987, p. 167).

Psychology should research the structure of every particular field of human knowledge, should build hierarchical developmental models for each one, should point out the relations between each level of development of this hierarchy and the cognitive abilities and metacognition, and finally should specify the responsible factors for the creation of individual differences as well as the manner in which these factors interact in each field of reality. This point needs attention because the success or failure of every course will be dependent upon the reliability of the research and also upon the aspect that will be adopted for the architecture, structure, and development of the human mind.

Pedagogical Problems

In recent years much has been learned about expertise in many different areas, and one way to view education is "as the conveying of expertise to children. We continue to expect our children to be *facile* at the basic skills of reading, writing, and arithmetic computation, but increasingly, we also expect them to respond flexibly, like experts, to continuing technological change (Lesgold, 1987, p. 20).

On the other hand, time exerts great pressures on education. Pressures produced by the time problem combined with other weaknesses of educational systems have led to widespread belief that educational standards have been lowered. The rapid pace of our society, and particularly the media, reinforces the belief of many children that skills can be acquired very quickly. Most teachers do not have the opportunity to attend a training course during their career. In science the amount of important knowledge continues to grow and it is easier for those responsible to add to the curriculum than to redesign it. This is the picture of education all over the world. The curriculum of the school of the future must be redesigned. We will soon have a new cognitive science telling us how learning takes place and what is learned from certain standard components of schooling. We need to turn to our advantage new skills, new tools, new teaching methods, new time, and student division.

Conclusion

We have considered the school of the future. We have also pointed out some of the problems that should be solved. This demands hard worked from many scientists and the joint efforts of various scientific disciplines in order that our

dreams should be made reality. It may also be necessary to outlay a lot of money at time for scientific research. So much scientific potential and such a prohibitive amount of money is impossible for only one country to provide. There is the need to create an international institute which should research and join the efforts between the institutions all over the world. Furthermore, the national institutions should be activated to define their educational values and national ideals. They should also describe those specific factors of their nation, that would create the differentiation environment in which the cognitive abilities are growing. However, this is a vital question: If today a great number of illiterates exists all over the world, what is going to be the number of illiterates in the future under the new demanding conditions? This question needs to be answered.

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